

Appl. No. 10/658,961

Amdt. Dated Feb. 1, 2005

Reply to Office Action of Nov. 01, 2004

Amendments to the Specification:

The following is a marked up version of the substitute specification:

SPECIFICATION
PLANAR SURFACE ILLUMINATOR

BACKGROUND OF THE INVENTION

Field of the Invention

[0001] The present invention relates to a planar surface illuminator, and especially to a planar surface illuminator using point light sources and provided below a liquid crystal display (LCD) panel.

Description of the Related Art

[0002] Most users expect displays in portable devices, such as laptop and notebook computers, mobile phones and game devices, to have large, clear, bright viewing screens, equaling the performance of the cathode-ray-tube (CRT) monitors sitting on their desks. LCDs are one type of flat panel display (FPD) which satisfies these expectations. ~~But~~ However, because liquid crystals are not self-luminescent, LCDs need a planar surface illuminator which offers sufficient luminance (brightness) in a planar surface. Typically, planar surface illuminators have one of two types of light sources, one being linear sources, such as a cold cathode fluorescent lamp (CCFL), and the other being point sources, such as a light emitting diode[[s]] (LED). Different types of light sources require different planar surface illuminator design structures[[]].

[0003] As shown in FIG. 5, a conventional planar surface illuminator 10 which uses point light sources comprises a light guide plate 15 and three point sources 13 positioned at one side of the light guide plate 15. The light guide plate 15 couples

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with light beams emitted from the point sources 13 to create a planar surface illuminator for irradiating a liquid crystal panel (not shown). The point sources 13 are LEDs, each of which has an emission beam ~~of Gauss~~ known as a Gaussian beam. The ~~Gauss~~ Gaussian beam has an optical intensity distribution function shaped like a ~~Gauss~~ Gaussian curve.

[0004] In operation, the ~~Gauss~~ Gaussian beams from the LEDs 13 irradiate an end surface (not labeled) of the light guide plate 15, and may transmit in the light guide plate 15 or may be emitted out of the light guide plate 15 through an output surface (not labeled), which is perpendicular to the end surface. As seen in FIG. 5, ~~[[a]] lower intensity parts of the Gauss Gaussian beams illuminate[[s]] the areas D, E, F, G between and adjacent each two LEDs 13[[.]]. just there, so much so that in~~ In some areas near the mid-point ~~[[of]] between~~ each two LEDs 13, almost no beams are emitted ~~therefrom~~ out of the light guide plate 15. ~~Therefore, darkened~~ Darkened areas are formed near points D, E, F, and G. Therefore, the planar surface illuminator 10 can~~[[]]~~not produce ~~[[a]]~~ uniform brightness over an entire area of the liquid crystal display panel.

SUMMARY OF THE INVENTION

[0005] Accordingly, an object of the present invention is to provide a planar surface illuminator which provides ~~a more~~ highly uniform brightness to a liquid crystal display panel.

[0006] Another object of the present invention is to provide a planar surface illuminator which more efficiently utilizes the light energy of point light sources.

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[0007] To achieve the above objects, a planar surface illuminator for placement below a liquid crystal display panel comprises a light guide plate and a plurality of point light sources. The light guide plate has a bottom surface, an end surface, and a number of ~~dot-patterns~~ dots formed on the bottom surface. The point light sources are positioned at the end surface to irradiate the light guide plate. Darkened areas between the point light sources are lightened by placing special ~~dot-patterns~~ dots therein, which special ~~dot-patterns~~ dots are made of melamine-based fluorescent particles. The melamine-based fluorescent particles function as many small light sources, thus lightening the darkened areas. ~~Therefore, the~~ The brightness of the planar surface illuminator is thereby balanced and made more uniform.

[0008] Other objects, advantages and novel features of the present invention will be apparent from the following detailed description of preferred embodiments thereof with reference to the attached drawings, in which:

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a perspective view of a planar surface illuminator constructed in accordance with a preferred embodiment of the present invention from a bottom-side aspect;

[0010] FIG. 2 is a bottom plan view of FIG. 1;

[0011] FIG. 3 is a greatly magnified view of a small portion of a special ~~dot-pattern~~ dot for use in the darkened areas of FIG. 2;

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[0012] FIG. 4 is a bottom plan view of a planar surface illuminator constructed in accordance with a second preferred embodiment of the present invention; and

[0013] FIG. 5 is a perspective view of a conventional planar surface illuminator.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0014] Referring to FIG. 1, a planar surface illuminator 20 for installation below a liquid crystal display panel (not shown) comprises ~~[[a]]~~ an optical light guide plate 22 and a plurality of point light sources 21. The point light sources 21 are positioned to a side of the optical light guide plate 22. Light from the point light sources 21 couples with an optical input surface 221 of the optical light guide plate 22.

[0015] Similar to the point sources 12 shown in FIG. 5 with regard to the conventional planar surface illuminator 10, the point light sources 21 in FIG. 1 are LEDs, each of which has an emission beam in the form of a Gaussian-Gauss beam. The ~~Gauss~~ Gaussian beam has an optical intensity distribution function shaped like a ~~Gauss~~ Gaussian curve. In operation, the ~~Gauss~~ Gaussian beams from the LEDs 21 irradiate the input surface 221 of the light guide plate 22, and may transmit in the light guide plate 22, or may be emitted out of the light guide plate 22 from an output surface 222 which is perpendicular to the input surface 221. Absent ~~connective~~ any corrective structure, the result would be formation of darkened areas 223a adjacent and in between each two LEDs 21.

[0016] The optical light guide plate 22 is shaped substantially as a rectangular plane ~~plate~~ sheet, and comprises the optical input surface 221 adjacent to the point light sources 21, the optical output surface 222, a bottom surface 223, and three

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side surfaces 224. The input surface 221 defines grooves (not labeled) corresponding to each point light source 21. Alternatively, the optical light guide plate 22 can be substantially shaped as a wedge. To improve optical performance efficiency, reflective sheets or films (not shown) can be secured on the bottom surface 223 and the three side surfaces 224. The use of the reflective sheets or films ensures that virtually all the optical light beams from the point light sources 21 are eventually emitted from the optical output surface 222.

[0017] Referring also to FIGS. 2 and 3, a number of reflective ~~dot-patterns~~ dots 23 are formed on or applied to the bottom surface 223 in a uniform pattern to promote uniform emission of light from the optical output surface 222. Note that the ~~dot-pattern~~ dots 23 are all of a same size in a same column, but increase in size in a same ~~new~~ row as a distance away from the optical input surface 221 increases. The ~~dot-patterns~~ dots 23 are injection molded or printed on the bottom surface 223. To balance lack of illumination emitted from the darkened areas 223a and thereby to provide an even brightness to the liquid crystal display panel, some special dots ~~dot-patterns~~ 23a positioned in the darkened areas 223a ~~specialy~~ are made of melamine-based fluorescent particles 25 (see [[FIG.3]] FIG. 3). The ~~dot-patterns~~ dots 23a constitute the ~~connective~~ corrective structures referred to above. Diameters of the melamine-based fluorescent particles 25 are in a range of from 1 to 10 microns ~~[[. So]],~~ so as to correspond~~[[ed]]~~ to different emission wavelengths of the LEDs 21. Each melamine-based fluorescent particle 25 can be a mixture or one of green, red and orange fluorescent dyes polymerized with melamine particles. Excitation and emission wavelengths of the green fluorescent dyes are respectively about 506 and 529 nanometers, ~~[[:]]~~ excitation and emission wavelengths of the red fluorescent dyes are respectively about 636 and 686 nanometers, and excitation and emission wavelengths of the orange fluorescent dyes are respectively about 560 and 584 nanometers.

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[0018] In operation, when exited by light beams from the LEDs 21, the melamine-based fluorescent particles 25 function as many small light sources lighting the darkened areas 223a, and so the brightness of the planar surface illuminator 20 is balanced. Furthermore, light beams from the melamine-based fluorescent particles 25 do not lighten the darkened areas 223a only~~[[, they]]~~. The light beams also transmit into or out of other areas of the light guide plate 22, so that the optical energy of the LEDs 21 is are adequately utilized. The total brightness, therefore, is also increased.

[0019] Turning to FIG. 4, the ~~dot-patterns~~ dots 23 also can be uniformly spaced on the bottom surface 223, with all the ~~dot-patterns~~ dots 23 being of the same size. The special ~~dot-patterns~~ dots 23a in the darkened areas 223a are not made of melamine-based fluorescent particles 25, ~~it~~ but are instead just be coated with melamine-based fluorescent particles[[,]]. ~~it-also~~ This structure can also provide even brightness to the liquid crystal display panel.

[0020] It is to be understood, however, that even though numerous characteristics and advantages of the present invention have been set forth in the foregoing description, together with details of the structure and function of the invention, the disclosure is illustrative only, and changes may be made in detail, especially in matters of shape, size, and arrangement of parts within the principles of the invention to the full extent indicated by the broad general meaning of the terms in which the appended claims are expressed.